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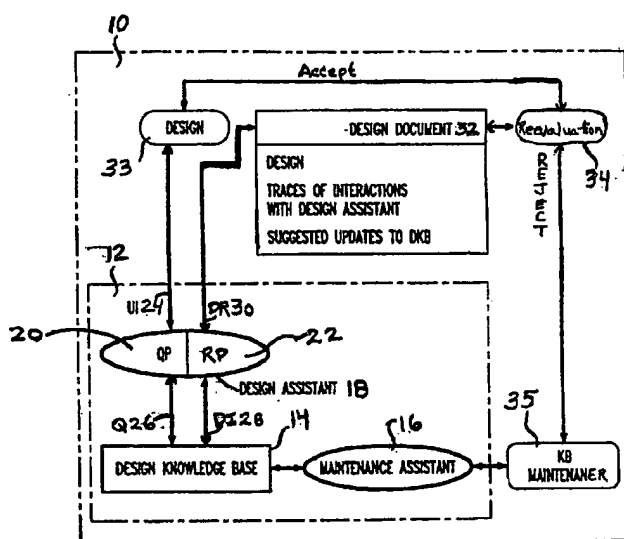
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| <p>(51) International Patent Classification⁷: G06G 7/48</p> <p>(21) International Application Number: PCT/US02/25784</p> <p>(22) International Filing Date: 14 August 2002 (14.08.2002)</p> <p>(25) Filing Language: English</p> <p>(26) Publication Language: English</p> <p>(30) Priority Data: 60/312,111 14 August 2001 (14.08.2001) US</p> <p>(71) Applicant (for all designated States except US): TEXTRON AUTOMOTIVE COMPANY INC. [US/US]; 750 Stephenson Highway, Troy, MI 48083 (US).</p> <p>(72) Inventors; and</p> <p>(75) Inventors/Applicants (for US only): ROSE, Jeffrey, A. [US/US]; 32444 N. River Road, Harrison Township, MI</p> | <p>48045 (US). DALPIZZOL, James, D. [US/US]; 17252 Kingsbrooke Circle, Apt. 104, Clinton Township, MI 48038 (US).</p> <p>(74) Agents: GROSSMAN, Steven, J. et al.; Grossman, Tucker, Perreault & Pfleger, PLLC, 55 South Commercial Street, Manchester, NH 03101 (US).</p> <p>(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.</p> <p>(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW),</p> |
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[Continued on next page]

- (54) Title:** METHOD FOR PROVIDING DESIGN REVIEW AND CONFORMITY



KEY

- | | |
|---|------------------------|
|  | ORGANIZATIONAL PROCESS |
|  | DOCUMENT |
|  | KNOWLEDGE BASE |
|  | COMPUTER PROGRAM |

(57) Abstract: A method and apparatus for updating a design knowledge base, comprising supplying a design knowledge base (14) containing information regarding designing in a selected domain, the design knowledge base configured to obtain user input (24) of a selected design and to output a design directive. A response is received from the design knowledge base to the user input of a selected design wherein the response comprises a set of design review inquiries to direct the user to incorporate the design directive. A knowledge base maintainer is supplied (35) in communication with design knowledge base wherein the knowledge base maintainer generates an output response in response to a user's response to the design review inquiries, wherein the output response directs the user to modify the user selected design to conform with the design directive or the user requests the knowledge base maintainer to confirm that the user's design comprises an improvement over the design directive provided by the design knowledge base wherein the knowledge base maintainer adjusts the design knowledge base to incorporate the improvement.



Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE,
ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SK,
TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, ML, MR, NE, SN, TD, TG).

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

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1 **METHOD FOR PROVIDING DESIGN REVIEW AND CONFORMITY**

2 **FIELD OF THE INVENTION**

3 This invention relates to information systems that produce a design review in
4 a particular design domain in order to help an information user, such as a designer
5 or engineer, designing in the domain.

6
7 **BACKGROUND OF THE INVENTION**

8 Computer systems have been utilized in an effort to develop expert systems
9 which include the capability of learning knowledge during operation. For example,
10 U.S. Patent No. 5,208,768 describes an expert system including an arrangement for
11 acquiring redesign knowledge.

12 More specifically, the expert system in the aforementioned patent is said to
13 perform a redesign in connection with an original design. The expert system
14 comprises a discrepancy determination component that identifies a discrepancy
15 between operation of the original design and the desired operation. A redesign
16 component including at least one redesign module associated with a discrepancy
17 generates a redesign in response to the original design and the identified
18 discrepancy. Finally, a redesign generation component generates a redesign module
19 in response to a previously identified discrepancy and design, the redesign module
20 thereafter being used by the redesign component.

21 Accordingly, a need remains to provide an improved knowledge-based
22 engineering system which provides design, manufacturing and/or business advice.
23 Therefore, it is a general object of this invention to provide such improved
24 knowledge-based engineering system, and more specifically, a system which
25 contains a closed feedback loop to the system user.

26 More specifically, it is also an object of the invention herein to provide such a
27 system, wherein the system provides relevant advice based upon expert knowledge
28 from engineers, integrated databases of related engineering information along with a
29 prioritization of attributes for the specific field.

30

SUMMARY OF THE INVENTION

A system and method of updating a design knowledge base, the method comprising the steps of receiving a response to a generated inquiry, and requesting the design knowledge base be reevaluated if a new design is conceived that is equal or better to an existing design if the response to the inquiry is negative. More specifically the present invention is directed at a method and apparatus for updating a design knowledge base, comprising supplying a design knowledge base containing information regarding designing in a selected domain, the design knowledge base configured to obtain user input of a selected design and to output a design directive. A response is received from the design knowledge base to the user input of a selected design wherein the response comprises a set of design review inquiries to direct the user to incorporate the design directive. A knowledge base maintainer is supplied in communication with the design knowledge base wherein the knowledge base maintainer generates an output response in response to a user's response to the design review inquiries, wherein the output response directs the user to modify the user selected design to conform with the design directive or the user requests the knowledge base maintainer to confirm that the user's design comprises an improvement over the design directive provided by the design knowledge base wherein the knowledge base maintainer adjusts the design knowledge base to incorporate the improvement.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects, features and advantages of the invention will become apparent upon consideration of the description of the invention and the appended drawings in which:

FIG. 1 illustrates the overall structure of the invention which includes the principal components of each of the mechanisms and how the mechanisms are employed in the design process; and

FIG. 2 illustrates the structure of the knowledge base in a preferred embodiment.

1 The above and other objects, feature, and advantages of the present invention
2 will be apparent in the following detailed description thereof when read in
3 conjunction with the appended drawings wherein the same reference characters
4 denote the same or similar parts throughout the several views.

5 6 **DESCRIPTION OF THE PREFERRED EMBODIMENTS**

7 As noted above, the present invention is directed at a method and system for
8 updating a design knowledge base, comprising supplying a design knowledge base
9 containing information regarding designing in a selected domain, the design
10 knowledge base configured to obtain user input of a selected design and to output a
11 design directive. A response is received from the design knowledge base to the user
12 input of a selected design wherein the response comprises a set of design review
13 inquiries to direct the user to incorporate the design directive. A knowledge base
14 maintainer is supplied in communication with the design knowledge base wherein
15 the knowledge base maintainer generates an output response in response to a user's
16 response to the design review inquiries, wherein the output response directs the user
17 to modify the user selected design to conform with the design directive or the user
18 requests the knowledge base maintainer to confirm that the user's design comprises
19 an improvement over the design directive provided by the design knowledge base
20 wherein the knowledge base maintainer adjusts the design knowledge base to
21 incorporate the improvement.

22 In system form, the present invention is directed at a design system,
23 comprising a design knowledge database storing a plurality of design parameters, a
24 maintenance engine adapted to change said design parameters in the design
25 knowledge database and a design engine adapted to interact with a design process
26 user to give the user access to relevant information from the design knowledge
27 database wherein said design engine further adapted to permit said user to create a
28 new design parameter not in said design knowledge database, store said new design
29 parameter in said design knowledge database, and further adapted to incorporate
30 said new design parameter in future designs.

1 In accordance with the invention, an exemplary design process 10 is shown in
2 **FIG. 1.** Design process 10 includes an artificial intelligence system 12 located
3 therein. The artificial intelligence system 12 comprises a design knowledge base 14,
4 a maintenance assistant 16, and a design assistant 18.

5 The design knowledge base 14 comprises information about designing in a
6 particular domain and may be used in a design review. The design knowledge base
7 14 comprises design information which may be queried, for example, by product
8 and/or process domains. For example, the domain may comprise product design
9 information related to automotive components for a motor vehicle. The automotive
10 components may comprise, but are not limited to, instrument panels, door panels,
11 bumpers, etc. The domain may also comprise process design information related to
12 polymer processing methods. The methods may comprise, but are not limited to,
13 injection molding, slush molding, painting, foam-in-place molding, etc.

14 The terms "computer program" and "software", as used herein, are to
15 be interpreted broadly as any computer-readable memory device holding one or
16 more executable processes. These processes are intended to be executed by a
17 processor in a manner consistent with the present invention. Also, the present
18 invention shall refer to various processes as interacting with humans or other
19 processes. Those skilled in the art will recognize that human interaction with any of
20 the foregoing processes may be accomplished, for example, using a graphical user
21 interface system to display relevant data and to permit human users to exchange
22 commands and data with the associated process.

23 Those skilled in the art will recognize that the knowledge base 14 represents a
24 database of design information. Each of the functional components associated with
25 the artificial intelligence system 12 is embodied by running distributed computer
26 program processes (e.g., generated using "full-scale" relational database engines such
27 as IBM DB2™, SQLServer™, Oracle 7.3™ or Oracle 8.0™ database managers) on
28 networked computer systems (e.g., comprising mainframe and/or symmetrically or
29 massively parallel computing systems such as the IBM SB2™ or HP™ 9000 computer
30 systems) including appropriate mass storage, networking, and other hardware and

1 software for permitting these functional components to achieve the stated function.
2 These computer systems may be geographically distributed and connected together
3 via appropriate wide- and local-area network hardware and software.

4 Alternatively, the aforesaid functional components may be embodied by a
5 plurality of separate computer processes (e.g., generated via dBase™, Xbase™,
6 MSAccess™ or other "flat file" type database management systems or products)
7 running on IBM-type, Intel Pentium™ or RISC microprocessor-based personal
8 computers networked together via conventional networking hardware and software
9 and including such other additional conventional hardware and software as is
10 necessary to permit these functional components to achieve the stated
11 functionalities. In this alternative configuration, since such personal computers
12 typically are unable to run full-scale relational database engines of the types
13 presented above, a non-relational flat file "table" (not shown) may be included in at
14 least one of the networked personal computers to represent at least portions of the
15 knowledge base data and/or input information thereto. Preferably, these personal
16 computers run the Unix, Microsoft Windows NT™ or Windows 98™ or Windows
17 2000™ operating systems. The aforesaid functional components of system 12 may
18 also be comprised by a combination of the above two configurations (e.g., by
19 computer program processes running on a combination of personal computers, RISC
20 systems, mainframes, symmetric or parallel computer systems, and/or other
21 appropriate hardware and software, networked together via appropriate wide and
22 local area network hardware and software).

23 The maintenance assistant 16 is a computer program that interacts with a
24 knowledge base maintainer 35 to change information, such as adding new
25 information, and/or revising or deleting existing information, in the design
26 knowledge base 14. Design information included in the design knowledge base 14
27 may be provided from multiple sources. For example, design information for the
28 design knowledge base 14 may be provided from technical experts in a particular
29 domain. Alternatively, design information for the design knowledge base 14 may be
30 provided from product and/or process quality initiatives, including product and

1 process validation reports. The source of the quality initiatives may comprise
2 historical data generated from previously utilized products and processes.
3 Exemplary quality initiatives include design failure mode and effects analysis
4 (DFMEA), process failure mode and effects analysis (PFMEA), production part
5 approval process (PPAP), 8D, statistical process control (SPC) and design of
6 experiments (DOE). Also alternatively, design information for the design
7 knowledge base 14 may be provided from warranty data, such as service reports.

8 The design assistant 18 is a computer program that interacts with a design
9 process user, such as a designer or engineer, to give the user access to relevant
10 information from the design knowledge base 14. Furthermore, the combination of
11 the design information in the design knowledge base 14 and the design assistant 18
12 must allow design process users easy access to relevant design information. As
13 shown in FIG. 1, the design assistant 18 comprises a query provider (QP) 20 and a
14 review provider (RP) 22.

15 The query provider 20 may be menu selection driven or keyword driven. In
16 first considering a menu driven query provider within the realm of product design,
17 for example, the design assistant 18 may be configured to obtain user input of his
18 specific design from a menu driven query comprising a tiered, descending hierarchy
19 (i.e. "decision tree") of design descriptions 40 as shown in FIG. 2, in which each sub-
20 domain is a subset of the previous domain.

21 For example, in the domain (D) of automotive components, the design
22 assistant may be configured to initially present a first-tier menu of sub-domains in
23 the next lower tier comprising instrument panel assemblies D_{1-1} and bumper
24 assemblies D_{1-2} , etc. to D_{1-N} , where the first numerical character represents the level
25 and the second numerical character represents the specific number of the selection
26 and n represents the total number of selections.

27 In continuing with the tier down, upon user input of a first-tier selection D_{1-N}
28 from the first-level tier down removed from the domain, the design assistant 18 may
29 then be configured to next present a second-tier menu comprising sub-domains from
30 the next lower level. For example, upon selection of a first-level user input D_{1-2} , such

1 as a bumper assembly, the design assistant 18 would be configured to present a
2 second-tier menu of sub-domains comprising the individual components of the
3 bumper assembly, such as the fascia D₂₋₁ and energy absorber D₂₋₂.

4 Upon user input of a second-tier selection D_{2-N} from the second-level tier
5 down removed from the domain, the sub-domains may be further sub-divided into
6 further design descriptions in the above manner (i.e. via presentation of, and user
7 selection from, an input selection menu) to reach the lowest level hierarchy of the
8 domain.

9 Alternatively, to the above menu driven query, the design assistant 18 may be
10 configured to obtain user input from a keyword query.

11 It should be understood that the goal of the above interaction is to allow the
12 design process user to classify his design under the most specific relevant design
13 description as to result in the most specific possible design review. Furthermore,
14 while the above operation of the design assistant 18 has been described relative to
15 product design, it should be understood that it equally applies to process design.

16 With regards to operation of the artificial intelligence system 12 within the
17 design process 10, the design process user (i.e. designer, engineer) first interacts with
18 the query provider 20 portion of the design assistant 18 by providing user input (UI)
19 24. As indicated above, the user input 24 may be input from a selection menu or
20 keyword.

21 Upon being provided with the user input 24, the design assistant 18 queries
22 the design knowledge base 14 with query (Q) 26 to access design information
23 relevant to the design process user. The design knowledge base 14 then provides
24 design information (DI) 28 to the design assistant 18. In turn, the review provider 22
25 portion of the design assistant 18 presents the relevant information as design review
26 (DR) 30 to the design process user as review inquires.

27 In response to the user design description input, a design document 32
28 comprising a predetermined set of design review inquires (e.g. questions), with a
29 priority ranking, such as high, medium or low for each inquiry, is generated from
30 the reviewer provider 22 portion of the design assistant 18. The inquires are

1 configured to elicit a binary (e.g. affirmative "yes" or negative "no") response from
2 the user concerning their design, and may be generated at any tier level of the design
3 knowledge base 14. Preferably, the inquiries are structured in which an affirmative
4 answer is the "correct" choice (i.e. the design is in conformance with the design
5 information contained in the design knowledge base 14).

6 Depending on the priority of the inquiry, a response from the user which is
7 found not to be in conformance with the design information in the design
8 knowledge base 14, preferably automatically generate an output response (e.g. e-
9 mail) from the knowledge base maintainer 35 informing the user that the design is
10 not in conformance with the design information in the design knowledge base 14,
11 and directing the user to modify his design into conformity with the design
12 information in the design knowledge base 14. Such a response from the knowledge
13 base maintainer 35 is typically reserved for high priority inquiries.

14 If the design process user is of the belief that any aspect of his design is
15 improved from the current design directive provided by the design knowledge base
16 14, the design process user may request (e.g. e-mail) a reevaluation 34 to be
17 conducted by the knowledge base maintainer 35 to confirm/disconfirm such. If the
18 knowledge base maintainer 35 confirms that the design process user's design
19 comprises an improvement over the existing design directive provided by the design
20 knowledge base 14, the knowledge base maintainer 35 will revise the design
21 knowledge base 14 to incorporate the improvement provided by the design process
22 user.

23 Maintaining the design knowledge base 14 involves the knowledge base
24 maintainer 35 interacting with the maintenance assistant 16 to update the design
25 knowledge base 14 based on the modifications and additions discovered to be
26 necessary during design 33 and reevaluation 34.

27 Upon revision of the design knowledge base 14 to incorporate such,
28 preferably an output response (e.g. e-mail) is automatically generated from the
29 knowledge base maintainer 35 informing the user that his design improvement has

1 been incorporated into such, and that his design is in conformance with the design
2 information in the design knowledge base 14.

3 As can therefore be seen from the above, the system herein provides relevant
4 advice regarding an design input and a comparison between the advice and the
5 design are automatically performed through an HTML search engine. Results of the
6 comparison become part of a user and design gate review document integral to the
7 system. The advice becomes part of a living design document. The system includes
8 a method of updating the knowledge base, and requires feedback to the expert
9 system if deviant from the expert advice. A preferred embodiment of the system is
10 used to provide advice through a graphical interface to designers located on an
11 engineering software system.

12 The description and drawings illustratively set forth the presently preferred
13 invention embodiments. The description and drawings are intended to describe
14 such embodiments and not to limit the scope of the invention. Those skilled in the
15 art will appreciate that still other modifications and variations of the present
16 invention are possible in light of the above teaching while remaining within the
17 scope of the following claims. Therefore, one may practice the invention otherwise
18 than as the description and drawings specifically show and describe.

1 We claim:

2 1. A method of updating a design knowledge base, comprising:

3 (a) supplying a design knowledge base (14) containing information
4 regarding designing in a selected domain, said design knowledge base configured to
5 obtain user input (24) of a selected design and to output a design directive;

6 (b) receiving a response from said design knowledge base to said user
7 input of a selected design wherein said response comprises a set of design review
8 inquiries to direct said user to incorporate said design directive;

9 (c) supplying a knowledge base maintainer (35) in communication with
10 said design knowledge base wherein said knowledge base maintainer generates an
11 output response in response to a user's response to said design review inquiries,
12 wherein said output response:

13 (i) directs said user to modify said user selected design to conform with said
14 design directive; or

15 (ii) said user requests said knowledge base maintainer to confirm that said
16 user's design comprises an improvement over said design directive provided by the
17 design knowledge base wherein said knowledge base maintainer adjusts said design
18 knowledge base to incorporate said improvement.

19

20 2. The method of claim 1 wherein said design knowledge base containing
21 information regarding designing in a particular domain is configured for designing
22 automotive components.

23

24 3. The method of claim 2 wherein said design knowledge base comprises
25 historical data generated from previously utilized products and processes.

26

27

28 4. A method of communicating with a design knowledge base to inform a
29 user about designing in a particular domain, comprising:

1 (a) supplying a design knowledge base (14) containing information
2 regarding designing in a selected domain, said design knowledge base configured to
3 obtain user input (24) of a selected design and to output a design directive;

4 (b) receiving a response from said design knowledge base to said user
5 input of a selected design wherein said response comprises a set of design review
6 inquiries to direct said user to incorporate said design directive;

7 (c) supplying a knowledge base maintainer (35) in communication with
8 said design knowledge base wherein said knowledge base maintainer generates an
9 output response in response to a user's response to said design review inquiries,
10 wherein said output response directs said user that said user selected design does
11 not conform with said design directive.

12

13 5. The method of claim 4 wherein said design knowledge base containing
14 information regarding designing in a particular domain is configured for designing
15 automotive components.

16

17 6. The method of claim 5 wherein said design knowledge base comprises
18 historical data generated from previously utilized products and processes.

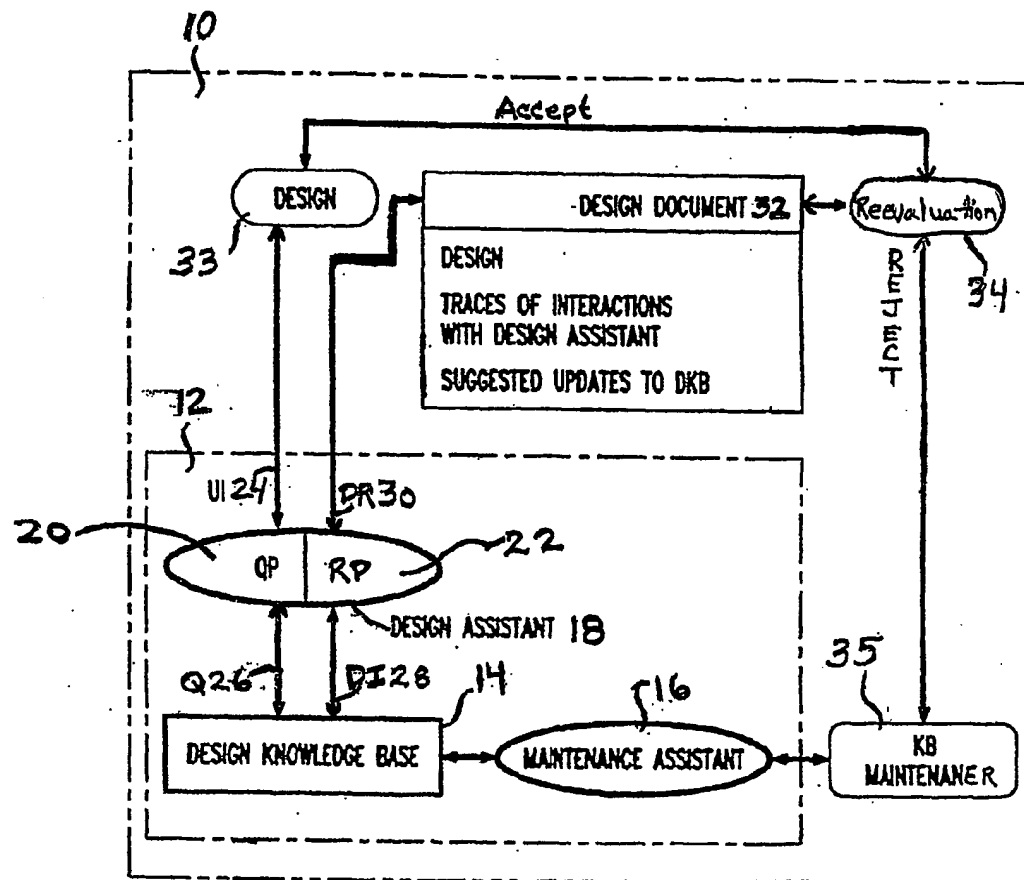
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20 7. A design system, comprising:
21 a design knowledge database storing a plurality of design parameters,
22 a maintenance engine adapted to change said design parameters in the design
23 knowledge database; and

24 a design engine adapted to interact with a design process user to give the user
25 access to relevant information from the design knowledge database;

26 wherein said design engine further adapted to permit said user to create a
27 new design parameter not in said design knowledge database, store said new design
28 parameter in said design knowledge database, and further adapted to incorporate
29 said new design parameter in future designs.

FIG. 1



KEY

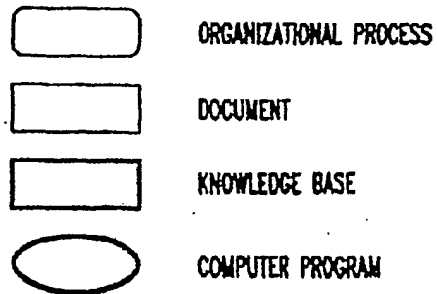
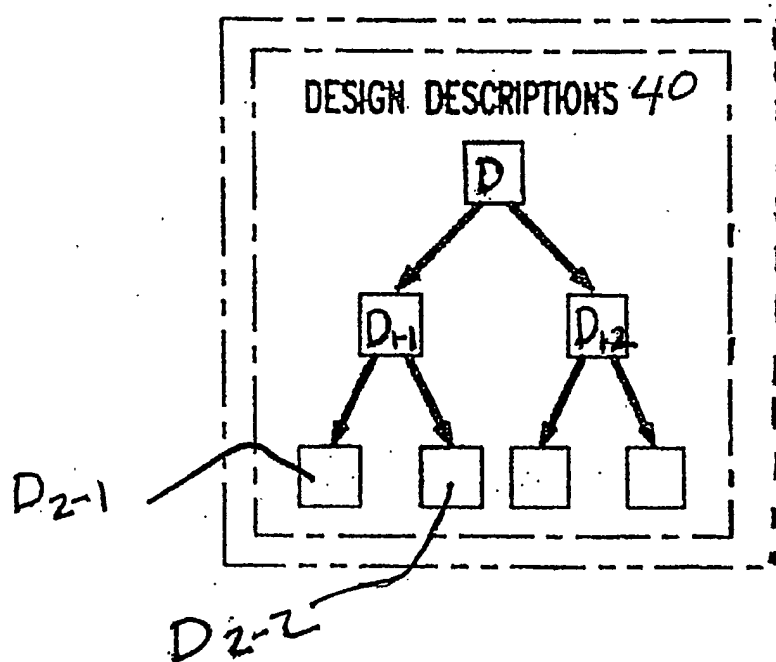


FIG. 2



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US02/25784**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(7) : G06G 7/48

US CL : 703/6

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 703/6, 2, 7

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

ACM, IEEE, EAST

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|--|-----------------------|
| X | US Re. 36,602 ^A (SEBASTIAN et al.) 7 March 2000, fig. 6-7 and corresponding text. | 1-7 |
| X | US 5,546,321 ^A (CHANG et al.) 13 August 1996, fig. 1-2, 6, 8, 11-12 and corresponding text. | 1-7 |
| X | US 5,218,557 ^A (SIMOUDIS) 8 June 1993, fig. 1, 3-4 and corresponding text. | 1-7 |
| X | US 5,388,188 ^A (SELFRIDGE et al.) 7 February 1995, fig. 1-2 and corresponding text. | 1-7 |

☐ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

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| * Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed | | "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "Z" document member of the same patent family | |
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22 SEPTEMBER 2002

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29 OCT 2002

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